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(54) Friction element such as a brake pad

(57) The element is adapted to frictionally engage a movable tack e.g. a baking surface on a disc, ring, drum or band and comprises a support (13) to which is secured a friction lining (14), the support being formed with a gradually varying thickness (e.g. at *e* and E) so that the distribution R of the pressures P over the application face (18) of the lining conforms to a pre-selected distribution, for example and as shown a uniform distribution. The ability to vary the distribution of pressures over the application face enables the wear pattern of the lining to be controlled. A number of embodiments are disclosed, e.g. in Figs. 1–4 thickness of support (13) is lower at *e* where support is acted on by a piston (15). Variation in thickness of support may be formed by provision of ribs produced by corrugations. The ribs may have reinforcements. Patterns of ribs are disclosed. Details of composition of the support and lining are given—and production of the element by moulding.

FIG. 4

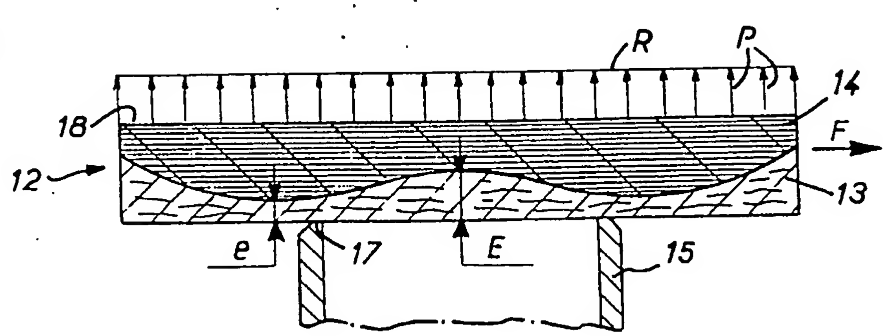

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FIG.1

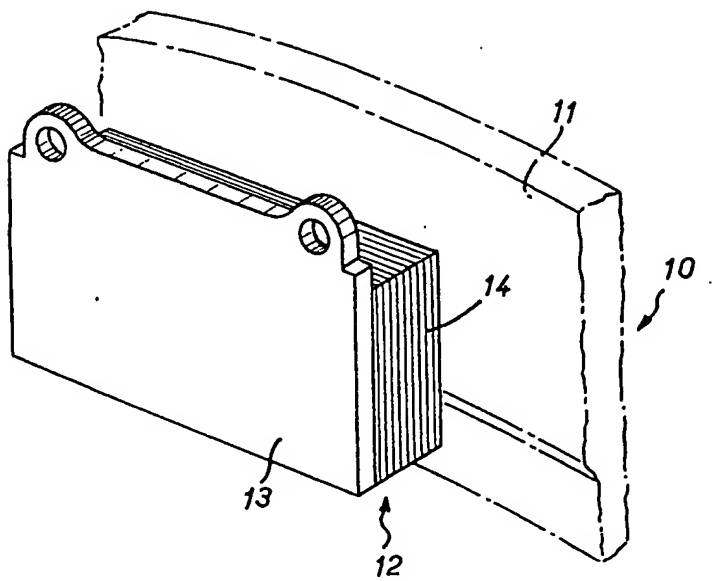
11
10
14
13
12

FIG.2

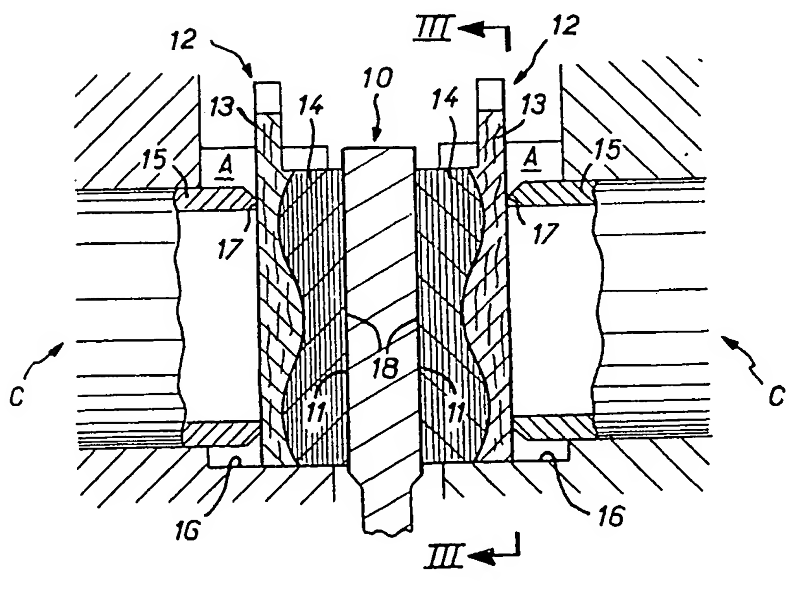
III
12
12
10
13
14
14
13
15
A
A
15
17
17
18
C
C
11
11
16
16
III

FIG.3

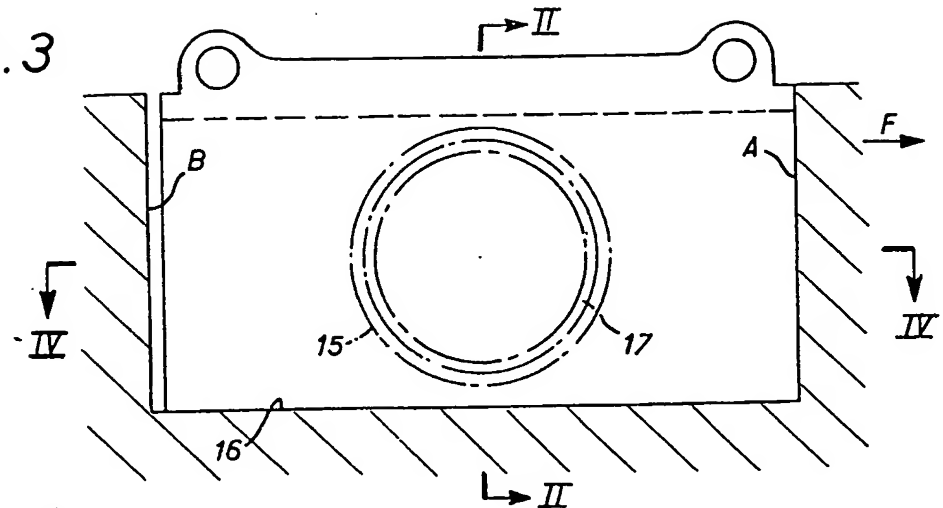

FIG.4

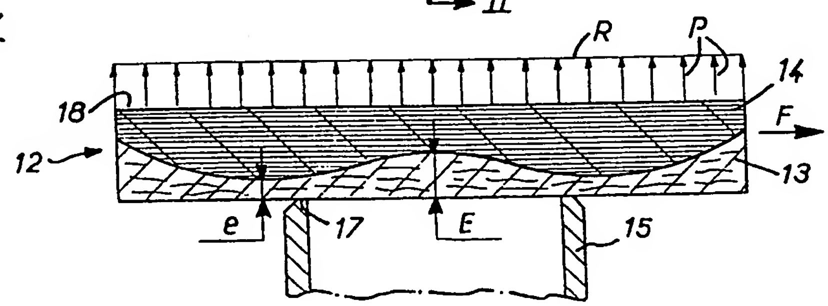

FIG.4A

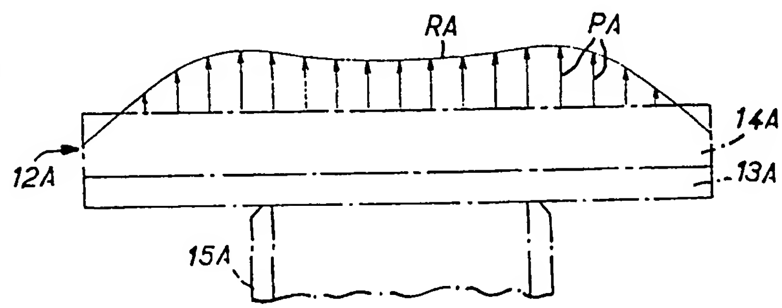

FIG.5

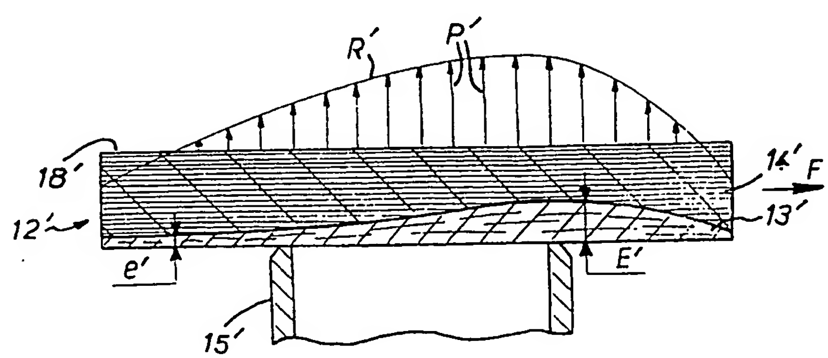

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FIG.6

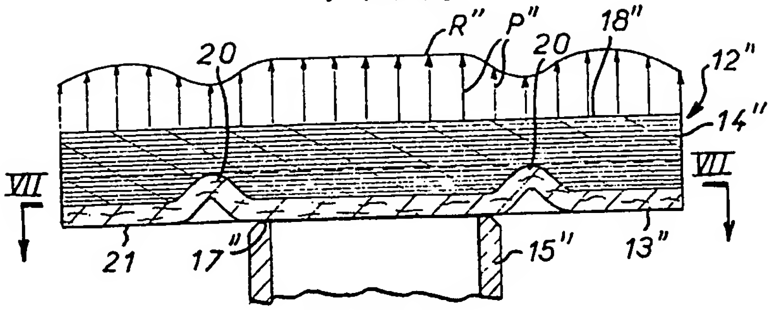


FIG.8

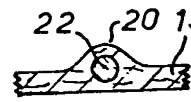


FIG.7

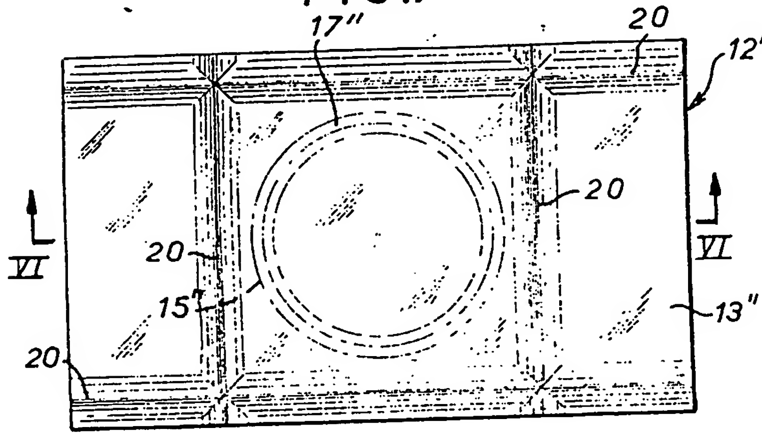


FIG.9

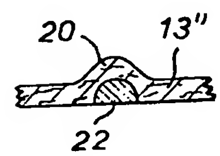


FIG.11

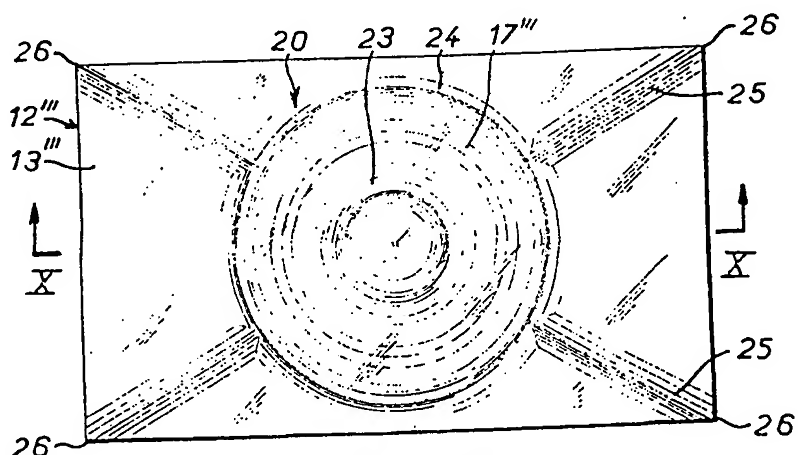
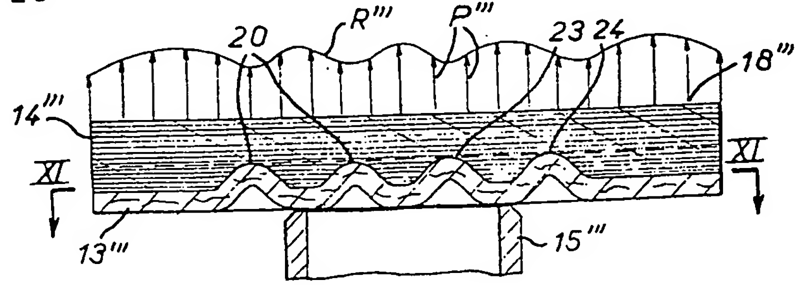


FIG.10



SPECIFICATION

Friction element such as a brake pad

The present invention relates to a friction element such as a brake pad, which is intended to frictionally engage a movable track, such as a braking surface formed on a brake disc, ring, drum or band. More particularly, the invention relates to friction elements of this kind comprising a support which is intended to cooperate with a control device, and a friction lining fixed to the support which is adapted for frictional contact with the track, the friction lining being applied over an application face, in response to the action of a force developed by the control device on the support and resulting in a distribution of pressures over the application face.

In general, where the element comprises a brake pad, the support is made of laminated metal and is of constant thickness. This results in a pressure being applied to the track, over the application face of the friction lining, which can be adequate as a whole, but which does not necessarily correspond to the optimum distribution of pressures desirable for the method of application, or which can even give rise, in certain cases, to non-uniform operation and to risk of deformation. Furthermore, during use of the pad, the wear on the friction lining is not uniform but is increased at the upstream end of the pad, considered in the direction of rotation of the disc. As a result, the worn pad is given a self-generating chamfer at this end and this leads to rather unsatisfactory operation beyond a certain degree of wear.

The Applicants have found that the thickness of the support influences the distribution of pressure on the moving track, over the application face of the friction lining, and that there is substantially a true correlation over the area of this application face, between the thickness of the support at one point, and the application pressure at this point.

The object of the present invention is to provide a friction element such as a brake pad, which is designed frictionally to engage a movable track such as a brake disc, ring, drum or band, and which does not suffer from the various above mentioned disadvantages, which has excellent operating conditions characteristics, and which is of simple and convenient construction.

According to the invention, a friction element, in particular a brake pad, which is designed frictionally to engage a movable track, such as a brake disc, ring, drum or band, comprises a support which is intended to cooperate with a control device, and a friction lining which is designed to be pressed against the said track, over an application face, in response to the action of a force developed by the control device on the support, this force resulting in a distribution of pressures over the said application face. The friction element is characterised in that the support is formed with a gradually varying thickness so that the distribution of the pressures over the application face conforms to a distribution chosen in advance.

By virtue of this arrangement, by suitably varying the thickness of the support, it is possible to obtain a pressure distribution on the track, over the application face of the friction lining, which corresponds to the optimum distribution for the envisaged method of application, for example a uniform distribution and, if appropriate, a distribution corrected for avoiding chamferlike wear at the upstream edge of the pad.

In one embodiment of the invention, the thickness of the support is lower in the zone where the support is operatively engaged by the control device, so that the distribution of the pressures over the application face is approximately uniform; in a modified embodiment, the support is given a greater thickness in the downstream region, considered in the direction of displacement of the track, so that the distribution of pressures over the application face gives rise to a higher pressure in the downstream region of the pad in order to avoid increased wear of the lining in the upstream region. These two arrangements can suitably be combined with one another.

According to another characteristic, the variations in the thickness of the support are gradual so as to avoid abrupt jumps in pressure over the application face.

Preferably, the support is made of a composite material comprising, in particular, layers of fabric, for example glass-fibre fabric, which are superposed in numbers varying according to the region of the support, and are impregnated with a binder which is preferably a phenolic resin. By virtue of this arrangement, the variations in the thickness of the support can easily be produced. Moreover, a pad formed in this way has a gentle, silent and efficient operation, with good thermal insulation, and is fairly resistant to corrosion.

Preferably, the friction lining is made of a substance which is compatible with that of the support, and comprises a binder formed by a resin of the phenolformaldehyde type, fibres and fillers.

In one embodiment, the support possesses ribs which define the variations in the thickness of the support.

These ribs can have any suitable configuration, for example a crosswise configuration, and they have the effect of increasing the strength of the support at the same time as making it possible conveniently to obtain the preselected pressure distribution.

The ribs are advantageously located on the same side as the friction lining, so that the external face of the support is approximately plane.

It is preferred to provide reinforcements embedded in the ribs. These reinforcements can have any suitable cross-section, for example round or truncated. These reinforcements can consist of a steel or carbon filament or of any other appropriate material.

The ribs advantageously extend in the region of the zone where the support is operatively engaged by the control device.

In order that the invention may be more fully understood, embodiments in accordance therewith will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a partial schematic view, in perspective, of a disc brake incorporating a friction element according to the invention;

Figure 2 is a partial schematic view of this brake, on a larger scale, in vertical cross-section along the line II–II of Fig. 3;

Figure 3 is a corresponding schematic view in longitudinal vertical section along the line III–III of Fig. 2;

Figure 4 is a view of the brake pad in horizontal section along the line IV–IV of Fig. 3 and illustrates the distribution of the pressures, which, in the case of Figs. 1 to 4, is chosen to be uniform by virtue of a suitable variation in the thickness of the support;

Figure 4A is a view similar to Fig. 4 and shows what the distribution of the pressures would be if the support had the customary constant thickness;

Figure 5 shows a modified embodiment in which the support is given a varying thickness so that the distribution of the pressures makes it possible to avoid increased chamfer-like wear at one of the ends of the pad;

Figure 6 is a view of another embodiment of friction element, in section along the line VI–VI of Fig. 7;

Figure 7 is a view in elevation of only the support of this embodiment, in the direction of the arrows VII–VII of Fig. 6;

Figure 8 shows a modified embodiment, in which the ribs of the support of the friction element are provided with a reinforcement;

Figure 9 is a similar view to Fig. 8 but shows another embodiment;

Figure 10 is a similar view to Fig. 6 but relates to another embodiment of friction element, in section along the line X–X of Fig. 11; and

Figure 11 is a view in elevation of only the support of this embodiment, in the direction of the arrows XI–XI of Fig. 10.

The embodiment shown in Figs. 1 to 4 relates, by way of a non-limiting example, to the application of the invention to a brake pad used in a disc brake for a motor vehicle. This disc brake comprises a rotating disc 10 (Figs. 1 and 2) possessing two opposite friction tracks or braking surfaces 11. A brake pad 12 frictionally cooperates with each track 11. The pad 12 comprises a support 13 engaged by a control device C, and a friction lining 14 carried by the support 13. In the non-limiting example shown, the two pads 12 and their arrangements are symmetrical relative to the disc 10.

Mountings are provided in order to hold each pad 12 opposite its associated track 11, whilst at the same time enabling it to move towards and away from the track, and these comprise, in the example shown in Figs. 2 and 3, a fixed housing 16 which slidably accepts the pad 12. This housing 16 possesses lateral bearings A and B for containing the braking reaction.

The control device C of each pad 12 comprises a hollow piston 15 which is subjected to a hydraulic pressure for pushing the pad 12 towards the track 11. The annular zone over which the control piston 15 bears on the support 13 is shown at 17 in Figs. 2 to 4. The friction lining 14 of each pad 12 is designed to be pressed onto the track 11, over an application face 18, in response to the action of a force developed by the piston 15 on the support 13, over the zone 17, and resulting in a distribution R of the pressures P over the application face 18. A line which illustrates this distribution of the pressures P is shown by R in Fig. 4.

At the moment of braking, the braking reaction is contained by the bearing A when the disc 10 is rotating in the direction of forward movement, illustrated by the arrow F (Figs. 3 and 4), and is contained by the bearing B when the disc is rotating in the reverse direction.

The support 13 is given a gradually varying thickness so that the distribution R of the pressures P over the application face 18 conforms to a pre-selected distribution. In the example shown in Figs. 1 to 4, the thickness of the support 13 is lower at *e*, in the zone 17 where the support 13 is acted upon by the control device 15, than in the other regions where the thickness is shown by E, so that the distribution R of the pressures P over the face 18 is approximately uniform (Fig. 4). Fig. 4 also shows that the variations in thickness between the value *e* and the value E are gradual, so that the thickness of the support 13 is free of abrupt variations.

In the embodiment shown in Figs. 1 to 4, the support 13 is made of a composite substance

comprising layers of glass-fibre fabric which are superposed in numbers varying according to the region of the support, and which are impregnated with a binder formed by a phenolic resin, whilst the friction lining 14 is made of a substance which is compatible with that of the support 13, and comprises a binder formed by a resin of the phenolformaldehyde type, fibres and fillers.

Non-limiting examples of the construction of the brake pade 12 are given below:

EXAMPLE 1

A sufficient number of plies, cut beforehand from a glass-fibre fabric pre-impregnated with phenolic resin, are stacked together. This number varies from one region to the other of the surface of the support 13 so as to give the shape shown in Figs. 2 and 4.

The support formed in this way is baked for 15 minutes at 170°C, under a pressure of 20 bars, in a mould having the shape of the stack indicated above.

That face of the support 13 which is adjacent to the face to the friction lining 14 is coated with a glue based on phenolic resin.

A friction material having the following composition by volume is moulded onto this glue-coated support:

resin of the phenolformaldehyde type	10 to 50
mineral fibres (basalt)	0 to 55
asbestos fibres	0 to 55
organic filler obtained by condensing cashew nut oil	0 to 15
carbon black	2 to 7
baryta	3 to 25
whiting	2 to 20
zircon	1 to 5
copper powder	0 to 15

The mixture having the above composition and forming the friction material of the lining 14 is pelletised under a pressure of 150 bars. This pelletised mixture is then moulded onto the support 13 for 8 minutes, at a temperature of 145°C, under a pressure of 375 bars.

EXAMPLE 2

A friction material which is to form the lining 14 is charged into a mould of the type which is commonly used in powder metallurgy and which makes it possible to form a moulding possessing two cross-sections, the said material having the following composition by volume:

CNSL-modified resin of the phenolformaldehyde type for friction elements	10 to 35
SBR-type synthetic rubber	5 to 15
sulphur	0.5 to 3
slag-type mineral fibres	15 to 40
metal fibres	0 to 40
asbestos fibres	0 to 45
organic fibres	0 to 15
ground brass wool	1 to 10
tin powder	0.5 to 4
litharge	5 to 15
antimony sulphide	1 to 7
baryta	10 to 25
magnesium oxide	1 to 10
silica	2 to 10
graphite	3 to 8
wood flour	2 to 7

This mixture is pelletised under a pressure of 70 bars to give the desired relief as shown in Fig. 4.

Two thicknesses of glass-fibre fabric weighing g/m² and pre-impregnated with phenolic resin are then positioned. Phenolic resin containing 35% by volume of 6 mm glass-fibre fibres as a filler is added. A glass fibre mat weighing 300 g/m² and pre-impregnated with phenolic resin is positioned. The whole is then baked for 10 minutes, at a temperature of 150°C, under a pressure of 250 bars.

It should be noted that the support can comprise either a glass-fibre fabric, or a glass-fibre mat, or a mixture of glass-fibre fragments, or a mixture of all or some of the above.

EXAMPLE 3

The procedure of Example 1 or Example 2 is followed, but, in addition, a reinforcement (consisting by way of a non-limiting example, of a wire gauze) is inserted into the support in the region of the lining and separated from the latter by at least about one millimetre. This wire gauze has the effect of strengthening the support in an advantageous manner.

EXAMPLE 4

The procedure of Example 1 or Example 2, and if appropriate of Example 3, is followed, but, in addition, an insert of high hardness is added, which approximately has the shape of the contact area 17 of the control device C and is arranged in the immediate vicinity of this area in order to prevent bruising.

The pad 12 produced in this way according to one of Examples 1 to 4 possesses, in section, the shape shown in Figs. 2 and 4, which show the support 13 and the friction lining 14 and which show that the thickness of the support 13 varies, with a reduced thickness *e* at the location of the zone 17 of contact with the hollow piston 15, and with a greater thickness E in the other regions.

A pad 12 formed in this way gives an approximately uniform distribution R of the pressures P, which permits excellent operation of this brake pad 12.

Fig. 4A shows what the distribution RA of the pressures PA would be if the support 13A had the customary constant thickness. In this case, the distribution RA of the pressures PA would not be uniform, but would fluctuate as shown in Fig. 4A, thus introducing an imbalance into the operation and risks of deformation.

Reference will now be made to Fig. 5, which illustrates a modified embodiment. The arrangement shown in Fig. 5 is similar to that which has been described with reference to Figs. 1 and 4, and the same reference numerals, followed by a prime, are used. The support 13 is given a varying thickness so that the distribution R′ of the pressures P′ over the face 18′ conforms to a distribution chosen in advance. However, in the example of Fig. 5, the thickness of the support is greater at E′, in the downstream region of the pad 12, considered in the direction of displacement F of the track 11, than in the upstream region, in which this thickness is indicated by *e′*. In this way, the distribution R′ of the pressures P′ over the application face 18′ gives rise to greater pressures downstream in order to avoid increased chamfer-like wear of the lining 14′ upstream.

Of course, the arrangement of Fig. 4 and that of Fig. 5 can advantageously be combined and, in this case, the support is given a varying thickness so as to combine the variations in thickness of Fig. 4 with those of Fig. 5, in order to obtain a distribution of the pressures which is as uniform as possible but which at the same time corrects the tendency towards increased chamfer-like wear of the pad 12 upstream.

When the lining has worn out, the fact that the support is allowed to rub, at least partially, against the disc 10 does not cause problems because, by virtue of its particular nature, the support is not likely to damage the latter.

Reference will now be made to Figs. 6 and 7, which show another modified embodiment of a disc-brake pad 12″.

The pad 12″ comprises a support 13″ which cooperates with a control device consisting of a hollow piston 15″. The pad 12″ also comprises a friction lining 14″ carried by the support 13″.

As in Figs. 1 to 4 or as in Fig. 5, the support 13″ is given a varying thickness so that the distribution R″ of the pressures P″ over the application face 18″ of the lining conforms to a pre-selected distribution.

In Figs. 6 and 7, the variation in the thickness of the support 13″ is produced by ribs 20 on the support 13″. These ribs 20 are located on the same side as the friction lining 14″ so that the external face 21 of the support 13″ is approximately plane. The ribs 20 extend in the region of the annular zone 17″ where the support 13″ is contacted by the control device 15″.

More particularly, in the example shown in Fig. 7, the ribs 20 have a crosswise distribution surrounding the zone 17″.

Preferably, as in Figs. 1 to 4, the support 13″ is made of a composite substance comprising layers of glass-fibre fabric which are superposed and impregnated with a binder formed by a phenolic resin, whilst the friction lining 14″ is made of material which is compatible with that of the support 13″, and comprises a binder formed by a resin of the phenol-formaldehyde type, fibres and fillers.

Whereas, in Figs. 1 to 4, the variation in the thickness of the support 13″ is more particularly produced by varying the number of layers of glass fabric, in this case the ribs 20 are produced by corrugating the layers of glass fabric.

In a modified embodiment shown in Fig. 8, the arrangement is similar to that described with reference to Figs. 6 and 7, but the support 13″ is provided with a reinforcement 22 embedded

in the ribs 20. This reinforcement 22 can be made of a steel filament or carbon filament or any other suitable substance. The reinforcement 22 has a round cross-section in the example shown in Fig. 8, but it can have any other appropriate cross-section, for example a cross-section of truncated shape, as shown in Fig. 9.

Reference will now be made to Figs. 10 and 11, in which the arrangement is similar to that described with reference to Figs. 6 and 7, and which shows the support 13''' and the lining 14''' of the pad 12''', but the ribs 20 have a different configuration from that shown in Fig. 7.

In the case of Figs. 10 and 11, the ribs 20 are arranged to form a first ring 23, located inside the zone 17''', and a second ring 24, located outside this zone 17''', and in diagonal extensions 25, which connect the outside ring 24 to the four corners 26 of the support 13''' of the pad 12'''. In Fig. 10, R''' shows the distribution of the pressures P''' over the application face 18'''.

The invention is not limited to the embodiments which have been described and shown, but includes any modified embodiments within the scope of the appended claims, including any kind of gradual variations in the thickness of the support in order to obtain any predetermined pressure distribution.

CLAIMS

1. A friction element adapted frictionally to engage a movable track, comprising a support which is intended to cooperate with a control device, and a friction lining adapted to be applied against said track, over an application face, in response to the action of a force applied by the control device to the support, said force resulting in a distribution of pressures over the said application face, whereby the support is formed with a gradually varying thickness such that the distribution of pressures over said application face conforms to a pre-selected distribution.

2. A friction element according to Claim 1, wherein the thickness of the support is lower in the zone at which the support is operatively engaged by the control device, so that the distribution of pressures over the said application face is substantially uniform.

3. A friction element according to Claim 1 or Claim 2, wherein the thickness of the support is greater in the downstream zone thereof, considered in the direction of displacement of the track, so that the distribution of pressures over the said application face gives rise to higher pressures at said downstream zone in order to avoid increased chamfer-like wear of the friction lining at the upstream zone thereof.

4. A friction element according to any of Claims 1 to 3, wherein the support is made of a composite material comprising a base material which has a thickness varying according to the region of the support, impregnated with a binder.

5. A friction element according to Claim 4, wherein the base material is glass, whilst the binder is a phenolic resin.

6. A friction element according to Claim 5, wherein the base material consists of a glass-fibre fabric disposed in superposed layers, the numbers of the layers varying according to the region of the support.

7. A friction element according to Claim 5, wherein the base product comprises a glass fibre mat.

8. A friction element according to Claim 5, wherein the base product comprises a mixture of glass-fibre fragments.

9. A friction element according to Claim 5, wherein the base material comprises a mixture of all or some of the following: a glass-fibre fabric, a glass-fibre mat and a mixture of glass-fibre fragments.

10. A friction element according to any of Claims 4 to 9, wherein the friction lining is made of a substance which is compatible with that of the support, and comprises a binder formed by a resin of the phenol-formaldehyde type, fibres and fillers.

11. A friction element according to Claim 10, wherein a glue based on phenolic resin is interposed between the support and the friction lining.

12. A friction element according to any of Claims 4 to 11, wherein the element comprising the support and the friction lining is baked under pressure.

13. A friction element according to Claim 1, wherein the support is provided with strengthening ribs.

14. A friction element according to Claim 13, wherein said ribs 20 are located on the same side as the friction lining.

15. A friction element according to Claim 13 or Claim 14, wherein one or more reinforcements are embedded in said ribs.

16. A friction element according to any of Claims 13 to 15, wherein the ribs are located in the zone where the support is operatively engaged by the control device.

17. A friction element, substantially as hereinbefore described with reference to Figs. 1 to 4, Fig. 5, Figs. 6 and 7, Fig. 8, Fig. 9, or Figs. 10 and 11 of the accompanying drawings.

18. A friction element, substantially as hereinbefore described with reference to any of

Examples 1 to 4.

19. A friction element according to any of Claims 1 to 18, comprising a brake pad.

20. The combination of a friction element according to any of Claims 1 to 19, a braking element comprising a brake disc, drum, ring or band on which is formed a braking surface comprising said movable track, and a control device operable to act on said support to apply said friction lining against said track.

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